SPM project: Parallel Prefix

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1 Introduction

In this report we will analyze, theoretically and practically, the resolution of the problem of the (parallel) prefix sum:

Given an input vector $\langle x_0, x_1, \ldots, x_{n-1} \rangle$ and a binary operation $\oplus$ compute the output vector $\langle x_0, x_0 \oplus x_1, x_0 \oplus x_1 \oplus x_2, \ldots, x_0 \oplus x_1 \oplus \ldots \oplus x_{n-1} \rangle$.

For the analysis of the problem we have to make two assumptions:

- The binary operation $\oplus$ is associative ($a \oplus (b \oplus c) = (a \oplus b) \oplus c$) and commutative ($a \oplus b = b \oplus a$), this is an important assumption as we will see in the next chapters the order of the operations may not be preserved.
- The size of the input vector is a power of 2, not a strong assumptions, as all the algorithms we will present could be easily generalize to all the sizes, but it helps to simplify some operations.

2 Sequential implementation

The sequential algorithm compute

The algorithm is optimal in a sequential model as it has a running time of $\mathcal{O}(n)$ and perform $n-1$ calls to $\oplus$ operation.

3 Parallel architecture design

3.1 Block-based algorithm

3.2 Circuit-based algorithm

4 Performance modeling

5 Implementations structure and details

5.1 Sequential algorithm

The sequential implementations

5.2 Block-based algorithm

5.3 Circuit-based algorithm

6 Experimental validation

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6.1 experiments details

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6.2 benchmark results

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7 Conclusion

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